

B 221, alloy 6063-T6 extruded aluminum channel, heliarc. The Contractor shall weld the corners to prevent moisture penetration and in locations where the Contractor requires attachment of panels to supports. *

(4) Splicing. Backing for signs four (4) feet by six (6) feet or less shall be of one (1) sheet. *

(C) Finishing.

(1) Enamel. The paint for background and details for metal signs shall be enamel and of type, quality and character to permit baking. The paint shall produce a true color tone and surface that is smooth, tough and without cracks or other blemishes. The yellow color tone, shown by reflected white light, shall show: *

(a) a dominant wave length of more than five hundred eighty (580) millimicrons or less than five hundred and eighty-eight (588) millimicrons, *

(b) a purity of more than eighty (80) percent, and *

(c) an integral pigment reflection of more than thirty-five (35) percent. *

Metal signs shall have: *

(a) one (1) prime coat by dipping or spraying, *

(b) at least one (1) coat of background paint on the back and *

(c) two (2) coats of background paint on the face.

The Contractor shall brush or spray the last coat. After the application of the last background coat, the Contractor shall bake the sign properly. The sign shall produce a tough flexible coating, not darken visibly, and be entirely free of blemishes. The Contractor may bake each background coat separately. *

The Contractor shall paint the details of signs with at least two (2) coats of the required paint by an accepted method. The Contractor shall then bake the paint as required for the background color. *

The finished design shall be clear cut and sharp. The lines of letters and details shall be true, regular, free from waviness, unevenness, fuzzy edges or lines, and free from cracks, scales, pits, blisters or blemishes.

The Contractor shall drill the two (2) holes for bolts for fastening the sign before the Contractor applies the finishing coat of paint. *

(2) **Porcelain Enamel.** Porcelain enamel shall have the quality and character to ease firing and fusing to the metal at a temperature above red heat. The enamel shall produce a true color tone and a surface that is smooth and without cracks, blisters or blemishes.

The Contractor shall coat the metal signs on the face and the back with one (1) ground coat and one (1) cover coat of porcelain enamel separately fired and fused to the metal at a temperature above red heat. The Contractor shall apply succeeding coats as necessary over these coatings. The Contractor shall fuse these coats to produce a single, integral coat of porcelain of the desired colors and designs in the finished plate. During the enamel coating and fusing, the Contractor shall hang the sign plates by hooks through a punched hole so no point marks, scars or other imperfections appear on the face of the sign plates. The signs shall have no surface defects.

The Contractor shall submit porcelain enamel color samples for acceptance before manufacture. Color shall conform to the National Bureau of Standards (N.B.S.) Procedure C429, using NES S-reflectance Standards No. SCR-11 as primary references. Porcelain enamel shall have a gloss reading of 50-70 units at an angle of forty-five (45) degrees when measured on the Photovolt meter according to ASTM designation C-346. The thickness of porcelain enamel on the face of the sign shall be more than 0.002 inch or less than 0.0051 inch. The Contractor shall establish the thickness according to ASTM designation D-1005 or D-1400 or methods equal or better accuracy.

Before enameling, the Contractor shall treat aluminum sheets with suitable metal treatment designed to produce maximum adherence of the porcelain enamel coating. The face of the sign shall have the required color. The back shall be free from "over-spray" or discoloration. To insure uniformity, the Contractor shall apply the porcelain enamel by automatic spray equipment conforming to P.E.I. Specifications ALS-105(57). Noticeable color differences on one sign shall be ± 0.01 when measured according to N.B.S. Procedure C429.

The Contractor shall check the adherence by the accelerated spall test according to P.E.I. Process Bulletin A1-1a, Section 6, dated March 24, 1959. The Contractor shall test on samples of twelve (12) inch by twelve (12) inch processed with production run. The Contractor shall test samples every one thousand (1,000) square feet of production cycle or total of order whichever occurs first. The Contractor shall use samples having undergone spall testing as parts of the signs in the contract. The porcelain enamel shall have acid resistance of Class B or better when tested according to the "Test for Acid Resistance of Porcelain Enamels" described in P.E.I. Bulletin T-7 or ASTM C 282, Standard Methods of Test for Acid Resistance of Porcelain Enamels. The porcelain enamel need only pass the Blurring-Highlights portion of the test. The porcelain enamel shall have a weight loss of more than twenty (20) milligram per

square inch. The porcelain enamel shall have a subsurface abrasion volume index of less than seven (7) when tested according to P.E.I. bulletin T-2 (Part IV Sub-Surface Abrasion). The Contractor shall divide the standard index by the density of the porcelain enamel defined in P.E.I. Bulletin A1-1a (Section 2 Abrasion Resistance) to get the volume index.

On surfaces exposed to weathering, the porcelain enamel coating shall be free of blemishes that may impair the serviceability or detract from the general appearance of the sign when viewed from a distance of twenty-five (25) feet or the distance that the Engineer normally views the sign whichever is greater.

(3) Type I (Engineering Grade) or Type II (Super Engineering Grade). The retroreflective sheeting shall include either:

(a) glass spheres embedded beneath a flexible transparent plastic that forms a smooth flat outer surface or

(b) plastic sheeting with minute lenses that are an integral part of and uniformly distributed over the entire surface of sheeting forming a smooth flat outer surface.

The visible color of the surface of the retroreflective sheeting and of the light reflected shall either be according to the contract or conform to a standard color sample furnished by the Department and the MUTCD.

The Contractor shall reflectorize the colors except black.

The retroreflective sheeting shall conform to ASTM D 4956-89.

The adhesive backing required for retroreflective sheeting shall conform to ASTM D 4956-89.

The adhesive shall form a durable bond on well painted surfaces, unpainted steel and aluminum, and on porcelain enamel.

The Contractor shall apply an edge sealer accepted by the Engineer to sheetings, splices, and edges of the sign.

The Contractor shall ship the retroreflective sheeting, when ordered separately, in sheets or rolls. The Contractor shall specify dimensions of the sheets in the purchase order. The Contractor shall pack the material in boxes so that the Contractor protects the material from injury or defacement during transportation. Each shipment includes the quantity of suitable adhesive necessary to attach the material to the surface.

The Contractor shall not emboss the signs made of retroreflective sheeting.

(4) Type III or IV Retroreflective Sheeting (High Intensity). A high intensity retroreflective sheeting is typically encapsulated glass-bead retroreflective material or unmetallized microprismatic retroreflective element material. The sheeting shall have a pre-coated adhesive or the backside protected by a removable liner.

(a) Color Requirements. The color requirements shall be according to ASTM D 4956-89.

(b) Intended Use. The contract intends to use retroreflective sheeting specified on surfaces of highway signs, traffic delineators, and barricade rails.

(c) General.

1. Test Conditions. The Contractor shall condition applied or unapplied test samples and specimens at seventy-two (72) degrees \pm two (2) degrees Fahrenheit and fifty (50) percent relative humidity (\pm 4 percent) for twenty-four (24) hours before testing.

2. Embossing. The Contractor shall not emboss the signs made with retroreflective sheeting.

3. Edge Sealing. The Contractor shall apply an edge sealer accepted by the Engineer to sheeting splices and edges for signs prone to oil or solvent splash or spray.

(5) Hardened Aluminum Backed Retroreflective Sheeting. The retroreflective sheeting used for the manufacture of this product shall conform to Subsection 712.20(C)(4) - Type III or IV Retroreflective Sheeting. The thickness of the hardened aluminum backing substrate shall be at 0.005 inch to 0.010 inch. The Contractor shall clean, degrease, and prepare the aluminum properly according to the accepted method recommended by the sheeting manufacturer.

The hardened aluminum backed retroreflective sheeting includes a pre-coated pressure sensitive adhesive backing (Class I) that the Contractor may apply to properly prepared smooth surfaces without the necessity of additional adhesive coats on either the sheeting or application surface.

The Class I adhesive shall be a pressure sensitive adhesive of the aggressive tack type requiring no heat, solvent or other preparation for adhesion to smooth, clean surfaces. The Contractor may require a surface primer for application to rough surfaces.

The Contractor shall subject the adhesive on the aluminum backing of the sheeting to an adhesion test as follows:

(a) Subject two (2) [two (2) inch by six (6) inch] pieces of the hardened aluminum backed retroreflective sheeting to a temperature of one hundred sixty (160) degrees Fahrenheit and a pressure of 2.5 pounds per square inch for four (4) hours.

(b) Bring the materials to equilibrium at seventy-two (72) degrees \pm two (2) degrees Fahrenheit and fifty (50) \pm four (4) percent relative humidity for twenty-four (24) hours.

(c) Cut one (1) [one (1) inch by six (6) inch] adhesion specimen from each piece and remove the liner by hand without the use of water or other solvents. During removal of the liner, note whether the liner adhesive breaks or tears from the backing. Failure of one (1) specimen shall constitute failure of the test.

(d) Apply four (4) inches of one end of each specimen to a smooth aluminum test panel of 6061-T6 or 5052-H38 alloy that is 0.020, 0.040, or 0.063 inch thick. The Contractor shall *|
prepare the panel according to ASTM B 449, Class 2 or degrease *|
and etch lightly. *|

(e) Suspend the test panels in a horizontal position with the specimen facing downward.

(f) Attach a four (4) pound weight to the free end of each specimen and allow the specimen to hang free at an angle of ninety (90) degrees to the panel surface for five (5) minutes.

(g) At the end of the five (5) minute period, check the distance of peeling that shall be less than two (2) inches. |

(h) Failure of one specimen shall constitute failure of the test.

(D) Sign Message and Accessories. The Contractor shall make the white *|
letters, numerals, symbols and borders from retroreflective sheeting on *|
individual aluminum cut-outs or individual embossed porcelain enameled |
aluminum cut-outs, containing reflex reflectors or hardened aluminum |
backed retroreflective sheeting, as required in the contract. |

(1) Aluminum Cut-Outs With Retroreflective Sheeting. Letters, *|
numerals and symbols shall be 0.040-inch thick aluminum sheet of *|
ASTM B 209, 3003-H14 alloy. Borders shall be 0.032-inch thick *|
aluminum sheet of ASTM B 209, 6061-T6 alloy. The Contractor shall *|
degrease and etch the aluminum or treat the aluminum with a light, *|
tight, amorphous chromate type coating.

The Contractor shall supply each letter, numeral, symbol and *|
border with mounting holes and secure them to the sign surface with *|
aluminum blind rivets. Blind rivets shall be the self plugging

type with a one-eighth (1/8) inch minimum diameter shank and five-sixteenth (5/16) inch minimum grip range. The Contractor shall apply the edge sealer to the completed units to assure a complete edge seal of the sheeting. *

The finished letters, numerals, symbols and borders shall show careful workmanship, be clean cut, sharp and have a plane surface.

The manufacturer shall certify that the letters, numerals, symbols and borders furnished conform to the contract. The manufacturer shall replace or repair without cost those failing to meet these requirements. *

The Contractor shall package the letters, numerals, symbols and borders to insure arrival at their destination undamaged. The Contractor shall not expose them to moisture in storage or shipment. *

(2) Porcelain Enameled Aluminum Cut-Outs With Acrylic Plastic Reflectors, Letters, Symbols And Borders. Porcelain enameled aluminum cut-outs with acrylic plastic reflectors, letters, symbols and borders shall be of the size and design to FHWA's "Standard Alphabets for Highways Signs".

Aluminum cut-outs with acrylic plastic reflex reflectors include embossed metal frames. The Contractor may install prismatic reflectors. The Engineer will not accept tape or adhesive. The Contractor shall make the metal frames from sheet aluminum more than 0.040-inch thick ASTM B 209, alloy 3003-T6. The Contractor shall clean the sheet thoroughly after fabrication and treat the sheet for corrosion protection. The Contractor shall finish the frames neatly according to the contract and have embossed edges. *

Frames shall have a white porcelain enamel finish. Metal parts of the letters, digits, symbols and borders shall withstand fifty (50) hours of salt spray according to ASTM B 117 with no evidence of pinholing. The Contractor shall fasten the frames to the panel background with aluminum blind rivets. Blind rivets shall be the self-plugging type. The number of blind rivets used shall be as accepted by the Engineer. *

The round reflectors include a clear, transparent face (lens) and a plastic back of identical material. The Contractor shall fuse the plastic back to the lens under heat and pressure around the perimeter to form a homogeneous unit. The Contractor shall seal the plastic back permanently against dust, water or water vapor. The Engineer will not accept reflector units assembled with gaskets. *

The lens include a smooth front surface free of projections or indentations other than for identification. The lens shall have a rear surface bearing a configuration such that the lens shall affect internal reflection of light without the aid of plating or separate reflector. *

The specific brightness of reflex reflectors shall be equal to or exceed the following minimum values.

Entrance Angle Degrees	Divergence Angle Degrees	Specific Brightness Candlepower (Sq. Inch) Foot-Candle
0	1/6	3.6
10	1/6	3.0
20	1/6	1.6
0	1/3	3.0
10	1/3	2.3
20	1/3	1.0

For testing optical performance, the Contractor shall use the following definitions: *|
*|

a. **Entrance Angle** - Angle at the reflector between direction of light incident on the reflector and direction of reflector axis.

b. **Divergence Angle.** Angle at the reflector between observer's line of sight and direction of light incident on reflector.

c. **Specific Brightness.** Candlepower returned at the chosen divergence angle, per square inch of reflecting surface for each foot-candle of illumination at the reflector.

(3) **Hardened Aluminum Backed Retroreflective Sheeting.** Letters, symbols, numerals and borders shall be of the size and design to FHWA's "Standard Alphabets for Highway Signs".

Materials shall conform to Subsection 712.20(C)(5) - Hardened Aluminum Backed Retroreflective Sheeting.

Fabrication shall be according to the manufacturer's instructions.

The letters, numerals, symbols and borders shall be clean cut, sharp and have a plane surface according to the contract.

The Contractor shall certify that the letters, numerals, symbols and borders conform to the contract. If they do not meet the contract requirements, the Contractor shall replace or repair them at no cost to the State.

The Contractor shall deliver the letters, numerals, symbols and borders undamaged and shall not expose them to moisture, oil or solvents during storage or shipment.

The Contractor shall make the background of the same material as the sign legend. The background shall be smooth, clean and dry before application of the sign legend. The Contractor shall install sign legend according to the manufacturer's instructions.

The Contractor shall edge seal the applied sheeting.

(E) Retroreflective Sheeting Materials. Retroreflective sheeting includes a white or colored sheeting having a smooth outer surface.

The Contractor shall classify retroreflective sheeting according to ASTM D 4956-89.

The general and minimum performance requirements for each type of retroreflective sheeting shall be according to ASTM D 4956-89 and/or AASHTO M 268.

The test methods and procedures shall be according to ASTM D 4956-89 and/or AASHTO M 268.

712.21 Reflector Marker.

(A) Glass Sphere Reflector Marker. The glass sphere reflector marker includes amber, red, or clear reflective sheeting. The glass sphere reflector marker shall have glass spheres embedded in a weatherproof synthetic sheet resin. The Contractor shall make the reflective face of plastic sealed optical system. The Contractor shall make a complete housing of anodized ASTM B 209, 5052-H34 aluminum alloy, 0.060-inch thick. The Engineer will permit the removal of the plastic face units only by removal of one (1) housing and cap. The Contractor shall not remove the end caps without the proper tools. End caps shall be interchangeable between housing sizes provided. Holes for mounting shall fit quarter (1/4) inch carriage bolts and fit posts having holes one (1) inch on centers.

(B) Plastic Prismatic Reflector Marker. The plastic prismatic reflector marker includes amber, red, or clear transparent acrylic plastic face (lens). The Contractor shall fuse the opaque back to the lens under heat and pressure around the perimeter. The Contractor shall fuse the opaque back to the lens to form a unit permanently sealed against dust, water and water vapor. The lens includes a smooth front surface free from projections or indentations other than for identification. The rear

surface of the lens shall reflect light and be of a prismatic *| configuration. The methyl methacrylate shall conform to Federal | Specifications L-M-500a, Type I, Class 3. The reflector shall be three (3) inches in diameter.

The Contractor shall house the reflector in a heavy duty ASTM B 209, 5052-H34 alloy, No. 0.060 gage unit with a separate back plate attached with four (4) vandal resistant nuts. The housing shall have a protective anodized coating. Holes for mounting shall fit quarter (1/4) *| inch carriage bolts and fit posts having holes one (1) inch on centers.

(C) Sheet Reflecting Material Marker. The marker includes a sheet | reflecting material on a 0.063 inch sheet aluminum backing. The sheet | reflecting material shall conform to of Subsection 712.20(C)(4) - Type | III or IV Retroreflective Sheeting (High Intensity). The backing shall | conform to Subsection 712.20(B)(1) - Sheet Aluminum. Holes for mounting | shall fit quarter (1/4) inch carriage bolts and fit posts having holes | one (1) inch on centers.

(D) Acrylic Resin Reflector Marker. The marker includes a microprism | sheeting made of clear or transparent colored (amber or red) ultraviolet | stabilized acrylic resin. The reflector thickness shall be a minimum | 0.005 inch and a maximum 0.025 inch. The outer surface of the reflector | shall be smooth with a specular gloss of one hundred seventy-five (175) | minimum specified in ASTM D 523.

The sheeting shall contain a minimum of forty thousand (40,000) reflective elements per square inch. The reflective elements shall be cube corner prisms made of acrylic resin. The Contractor shall coat the *| prism surface with a deposition of aluminum to protect against loss of | reflectivity due to dust, water, water vapor or penetration of the front | surface of the reflector.

The back surface of the reflector includes a pressure sensitive | adhesive coating protected by a removable release paper. Minimum | application pressure shall be twenty-five (25) pounds per square inch. | Minimum shear stress shall exceed ten (10) pounds per square inch at | seventy (70) degrees Fahrenheit after twenty-four (24) hours of curing | time. Shelf life shall exceed one (1) year.

The reflector shall have fifty (50) percent retention of the minimum specified intensity values after ten (10) years of continuous outdoor exposure.

The specific intensity of each reflector, when tested at 0.1 degree angle of divergence, shall meet or exceed the following values:

	Specific Intensity per Unit Area Candles per Foot Candle per Square Foot		
	White	Yellow	Red
-4° Incidence Angle	1472	946	315
30° Incidence Angle	660	424	140

(E) **Traffic Delineator Band.** The delineator band shall conform to the MUTCD for reflectorizing traffic delineators for nighttime use. The delineator band includes a flexible vinyl microprism sheeting heat sealed to white flexible vinyl sheeting around the periphery of the band.

The bands shall be of uniform width and have a smooth outer surface. *
The Contractor shall not reduce the reflectivity by more than ten (10) *
percent when wet.

The vinyl microprism sheeting used for traffic delineator bands *
includes a high gloss transparent UV light stabilized vinyl film bonded *
to a layer of vinyl cube corner prisms. The sheeting shall have no less *
than forty thousand (40,000) prisms per square inch. The microprism
sheeting shall conform to the following:

- (1) **Thickness:** 0.008 inch minimum,
- (2) **Specular Gloss:** one hundred seventy-five (175) minimum (ASTM D 523),
- (3) **Tensile Strength:** Two thousand six hundred (2600) pounds per square inch minimum (ASTM D 882),
- (4) **Modulus of Elasticity:** One thousand six hundred (1600) pounds per square inch minimum (ASTM D 882),
- (5) **Elmendorf Tear Test:** One hundred seventy (170) gms/MIL minimum (ASTM D 1922),
- (6) **Flexibility:** No sign of cracking or crazing when flexed repeatedly over a one-sixteenth (1/16) inch mandrel to one hundred eighty (180) degrees at twenty-five (25) degrees Centigrade shall occur,
- (7) **Impact Resistance:** One hundred sixty (160) pounds minimum (ASTM D 2794),
- (8) **Solvent Resistance:** Good resistance to methanol, kerosene, and turpentine when exposed for ten (10) minutes (LS300B requirement 3.5.3, method 4.3.6),

(9) **Abrasion Resistance:** One hundred (100) revolutions minimum (LS300B 4.3.14)

(10) **Color:** The colors used shall conform to the chromaticity requirement of LS300b.

(11) **Reflective Intensities:** When tested according to Federal Test *| Method 370, the minimum reflectivities shall be as follows: |

MINIMUM REFLECTIVITY (Candle power/foot candle/square foot)					
Divergence Angle	Incidence Angle	White	Orange	Yellow	
0.2	-4	250	70	150	
0.2	30	95	26	50	
0.5	-4	200	56	125	
0.5	30	60	17	25	

(12) **Accelerated weathering:** Retention of fifty (50) percent of initial reflective intensity minimum requirements after two hundred fifty (250) hours when tested according to LS300B. *|

NOTE: Manufacturers guarantee retention of fifty (50) per cent of initial minimum reflective intensities after two (2) year outdoor exposure.

The protective backing material used shall be opaque white plasticized vinyl film and shall conform to Items (1), (3), (4), (5), (6), (7), (8), and (9) above. |

712.22 Pipe Collar for Valve Box. Pipe collar or sleeve for valve boxes shall be ductile iron pipe conforming to AWWA C151. The diameter and length shall be according to the contract. |

712.23 Precast Concrete Meter and Valve Boxes and Covers. The Contractor *| shall make Types A, B and X Meter and Valve Boxes and Covers according to the *| contract. |

Portland cement concrete shall have a compressive strength of at least two thousand five hundred (2,500) pounds per square inch and conform to Section 601 - Structural Concrete. The maximum density of the concrete in the finished product shall be one hundred fifteen (115) pounds per cubic foot and the maximum absorption shall be fifteen (15) pounds per cubic foot. The combined aggregates shall be of such composition of sizes so that the surface of the finished product shall be continuous and of a uniform texture. |

712.24

712.24 Valves and Appurtenances.

(A) Gate Valves.

(1) **General.** Valves shall have non-rising stems with inside screw and open counterclockwise. The Contractor shall equip the valves with double O-ring stem seals conforming to AWWA C500. The Contractor shall locate both rings above the collar or with packing gland, cut in separate rings with staggered joints. Valves shall have the manufacturer's name, catalog number and working pressure. The Contractor shall mould or stamp them in places where they may be easily seen when the Contractor installs the valves. The Contractor shall paint the valves according to AWWA C500, Section 27 and furnish the valve complete with accessories. Caulked joint, mechanical joint, and flanged joint for gate valves shall be according to the applicable requirements specified for joints for cast iron pipe.

Gate valves shall be for buried service.

(2) **Three (3) Inch and Smaller Valves.** Valves shall be of the wedge-disc type with non-rising stem, screw ends and brass or bronze body. Metal composition of the body, centerpiece and other cast parts shall be copper alloy, 85-5-5-5 conforming to ASTM B 62. The packing shall have each ring cut to fit with staggered joints. The Contractor shall not use continuous (spiraled) packing. The Contractor shall provide the valves with handwheels and stuffing box glands. Valves shall be for two hundred (200) pounds water service.

(3) **Four (4) Inch and Larger Valves.** The Contractor shall make the valves with cast iron body, bronze (not brass) mounted, double disc, parallel seat. The Contractor shall furnish the valves with two (2) inch square operating nuts. Valves shall have either hub, mechanical joint or flanged joint ends according to the contract.

-- The Contractor shall provide sixteen (16) inch and larger valves with:

- (a) cast steel cut tooth, spur or bevel gears,
- (b) integral or extended gear case, lubricated,
- (c) watertight gland enclosure, and
- (c) bypass as follows:

Size of Valves (Inches)	Size of Bypass (Inches)
16 - 20 Inclusive	3
24 - 30 Inclusive	4

Valves except bevel-gear valves shall operate "upright" (vertical in horizontal pipe).

Bevel-gear valves shall operate on "edge" (horizontal in horizontal pipe). The Contractor shall equip the bevel-gear valves with solid bronze rollers, tracks and scrapers.

Valves shall be for one hundred fifty (150) pound or two hundred fifty (250) pound water working pressures. The Contractor shall design two-hundred (200) pound valves for two hundred fifty (250) pound working pressure and test to four hundred (400) pound.

(B) Butterfly Valves. Butterfly valves shall be Class 150-B and conform to AWWA C504 for Rubber Seated Butterfly Valves. Valves shall be the "short body" or "long body" type. Butterfly valves shall have cast iron bodies. The Contractor shall mount the rubber seat on valve disk or the valve body. If the Contractor mounts the rubber seat on the valve body, the disc shall be alloy cast iron according to ASTM A 436 (Type I Ni-Resist). If the Contractor mounts the rubber seat on the disc, the Contractor shall hold the rubber seat in place by 18-8 stainless steel clamps, and the mating seat surface shall be 18-8 stainless steel. The valve shaft and pins shall be 18-8 stainless steel, Type 303, 304 and 316. The bearing shall be self-lubricated nylon or teflon bearings. Valve ends shall be ANSI B16.1, Class 125 flanges. Bolt holes shall straddle the vertical centerline.

Butterfly valve shall be for buried service. The Contractor shall equip the butterfly valve with enclosed worm gear operators and two (2) inch square operating nuts. The operator shall conform to AWWA C504 for Rubber Seated Butterfly Valves. The rubber seated butterfly valves shall develop torque requirements according to Table I, Class 150-B, with a maximum input torque of one hundred fifty (150) foot-pounds. The operator shall be complete with:

- (a) built-in ninety (90) degrees or less adjustable stops, pointer-for-valve position indicator,
- (b) integral floating valve shaft coupling, and
- (c) means for orienting the operator on the valve in nearly every position.

The Contractor shall submit two (2) copies of the record of tests according to AWWA C504, Section 13.

The Contractor shall submit the following to the Engineer for acceptance by the County Water Supply System before the Contractor installs the valve:

- (1) Certification from the valve manufacturer that the valve and the operator conforms to AWWA C504.

- (2) Certified drawings of valve and operator according to AWWA C504. |
- (3) Certified copies of reports of the torque rating of the manual operator according to AWWA C504. |
- (4) Calculations showing required operator input torque to develop operating torque according to Table I, Class 150B, of AWWA C504. |

(C) Tapping Valve and Sleeve. Tapping valve and sleeve shall fit the A.P. Smith tapping machine. The Contractor shall furnish the valve and sleeve complete with bolts, nuts and other standard accessories. *)

Ends of sleeves shall be mechanical joint or lead joint to fit Class 150 or 250 Cast Iron Pipe. Sleeves shall have flanged end outlets for the valve connections.

The Contractor shall flange one end of the valve to fit the sleeve. *) The other end shall have hub or mechanical joint to receive the spigot *) end of the branch line. The manufacturer shall design the valve for one *) hundred fifty (150) pound or two hundred fifty (250) pound working *) pressure according to the contract. The manufacturer shall bevel-gear or *) spur-gear the valves in sizes sixteen (16) inch and large. Valves shall *) conform to Subsection 712.24(A) - Gate Valves. *)

(D) Globe Valves. Globe valves shall have screw ends and shall be of brass or bronze. Packing shall have each ring cut to fit, with staggered joints. The Contractor shall not use continuous (spiraled) packing. *)

Globe valves shall conform to the requirements for two hundred (200) *) pound water service.

(E) Air Relief Valves and Fittings. Air relief valves shall conform to *) minimum working pressures according to the contract. Valves shall be of *) compact size. The manufacturer shall design the valves so that the *) Contractor may install the valves in limited spaces. Valves shall be of *) the size according to the contract. *)

Body and cover shall be of heavy cast high-tensile iron according to *) ASTM A 126, Class C or semi-steel.

Valve and valve seat shall be of bronze according to ASTM B 62 or *) heat treated chrome steel.

The lever, float arm, pins and vent cock shall be of bronze *) according to ASTM B 62.

Floats shall be of the highest quality seamless copper or stainless steel and shall operate with adequate force to insure positive valve action.

The Contractor shall paint the air relief valves with two (2) coats *|
of asphalt varnish according to Federal Specification, TT-V-51F. *|

(F) **Valve Markers.** Valve markers shall be two (2) inch zinc-coated
pipe of standing weight or accepted equal. |

Fittings for connections of air relief valves shall be cast bronze,
screwed joint fittings with metal according to ASTM B 62. *|

Nipples shall be of "standard" brass, threaded on both ends. Their *|
metal composition shall be Grade A according to Federal Specifications *|
WW-P-351A.

Bushings and plugs shall be "standard" brass.

The manufacturer shall design the vertical check valve to operate *|
on upward flow only and shall be of brass or bronze. Valves shall be
for two hundred (200) pound working pressure.

Corporation stop shall be according to Subsection 707.11 - Copper *|
Service Pipe and Appurtenances.

712.25 Pipe Hangers, Lateral Bracings and Inserts. Pipe hangers and lateral
bracings shall be of carbon steel. The Contractor shall zinc-coat and make *|
the pipe hangers and bracings to the dimensions according to the contract. *|
The Contractor shall complete the pipe hangers with hanger rods and adjust *|
the pipe hangers vertically. *|

Pipe hanger inserts shall be gray iron castings according to ASTM A 48, *|
Class 30. The Contractor shall make inserts according to the contract. *|

712.26 Fire Hydrants and Appurtenances. Hydrants shall be according to AWWA *|
C503 and AWWA C502. |

--The Contractor shall subject the hydrants to a hydrostatic pressure test *|
of three hundred (300) pounds per square inch. The manufacturer shall *|
guarantee the pressure test. The Contractor shall submit two (2) copies of *|
the Certification of Test before delivery. *|

Length of hydrant buried is from the face of the flange to the |
centerline of the six (6) inch intake pipe.

The bell end of the six (6) inch intake pipe shall be mechanical joint |
or caulk joint and shall conform to joints for cast iron pipe. |

Castings and finished surface shall be according to the contract. *|
Machined parts on hydrants shall be interchangeable and shall fit the Board
of Water Supply's standard gages.

The manufacturer shall make and test at least one (1) test bar from each
heat of metal used according to applicable ASTM Specifications. *|

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The Contractor shall clean each hydrant body of oil, grease, dirt, or other loose material. The Contractor shall then paint each hydrant with an accepted hydrant paint. *

The Contractor shall mark hydrant parts distinctly with its name, part number, length, size and marker's name. The Contractor shall fasten the markings on cloth tags securely to the parts with wire or paint the markings on the parts or other means to insure positive identification of the parts upon delivery. *

The Contractor shall furnish each hydrant body with a set of break-off bolts, nuts, and full face gasket. The Contractor shall hot-dip zinc-coat the nuts and bolts. The bolts shall be five-eighths (5/8) inch by three (3) inch machine bolts with hexagon heads American Standard heavy. The Contractor shall drill the bolts eleven thirty-secondth (11/32) inch by one and three-eighths (1-3/8) inch. Nuts shall be American Standard heavy cold punched, hexagon nuts. Gaskets shall be one-eighth (1/8) of an inch cloth inserted rubber. *

712.27 Conduits.

(A) Steel Conduits. Steel conduits shall be rigid metal according to ANSI Standard C80.1 and Article 346 of the National Electrical Code. The Contractor shall hot-dip zinc-coat the exterior and interior surfaces of the conduits and fittings uniformly according to ASTM A 153. *

The Contractor shall submit a six (6) inch conduit sample, cut from the center of a standard length of conduit. The Contractor shall test the conduit according to ASTM A 239. The interior and exterior of the conduit shall not show a fixed deposit of copper after four (4) one-minute immersions in standard copper sulfate solution. *

The interior of the conduit shall have a continuous coating of zinc-chromate, lacquer or enamel. Each length shall bear the label of Underwriter's Laboratories, Inc.

(B) Plastic Conduits. Plastic conduit shall be rigid PVC and extruded standard wall Schedule 40 or Schedule 80 electrical conduit. Each length shall bear the label of Underwriters' Laboratory, Inc. *

(C) Liquid-Tight Flexible Metal Conduit and Fittings. Liquid-tight flexible metal conduit and fittings shall conform to UL 1. The Contractor shall jacket the conduit and fittings with PVC extrusion. The jacket shall be moisture-and-oil proof conforming to the minimum radius bends of flexible conduit without cracking. Fittings for liquid-tight flexible steel conduit shall have nondeteriorating, liquid-tight steel. *

712.28 Light Poles. Light poles shall be wood or metal according to the contract.

(A) Metal Poles. Metal posts may be zinc-coated steel posts or spun aluminum posts or other accepted designs. The Engineer will not permit a mixture of types. Posts shall have anchor base with four (4) high strength anchor bolts. The Contractor shall submit drawings for the proposed posts for acceptance according to Subsection 622.03(A) - Equipment List and Drawings. Posts mounted on walls and structures may not be of "breakaway" design. Posts mounted on walls and structures shall have anchor bases. Anchor base posts shall have side entry hand holes.

The Contractor shall supply each pole complete with bracket, base, ornamental pole top, base cover and anchor bolts. Brackets shall be upsweep type for pole lengths shorter than eight (8) feet and truss type for lengths eight (8) feet and longer. Bracket ends shall aid slipfitter luminaries. The pole end of each bracket member shall have a welded fitting that permits positioning of the bracket arm assembly on the plate of the pole, held by gravity, while the Contractor secures the arm to the pole.

The Contractor shall provide a grounding nut on the inner portion of the shaft opposite the handhole. The nut shall be steel or aluminum to match the shaft metal.

(1) Steel Poles. The manufacturer shall cold roll the steel poles into a round or octagonal tapered shape from highest grade open hearth steel. The thickness shall be more than No. 11 gage. After making the steel poles, the manufacturer shall hot-dip zinc-coat according to ASTM A 123. The Contractor shall repair damaged zinc-coated surfaces according to Subsection 501.03(G)(2) - Repairing of Damaged Zinc-Coated Surfaces.

(2) Aluminum Poles. The manufacturer shall spin draw the aluminum poles from seamless aluminum tubing according to ASTM B 221, alloy 6063-T6. The nominal thickness shall be at least 0.188 inch. The shaft shall not have circumferential nor longitudinal welds except at the lower end joining the shaft to the base. The manufacturer shall provide the poles with brackets of elliptical aluminum tubing according to ASTM B 221, alloy 6063-T6. During shipment, the Contractor shall spiral wrap the shaft with a protective paper that shall not discolor the pole under hot or wet conditions.

The manufacturer shall furnish the spun aluminum poles with polished natural aluminum finish. The hardware shall be stainless steel.

(B) **Wood poles.** Wood poles shall be of Southern Yellow Pine or Douglas Fir. The Contractor shall treat wood poles fully with pentachlorophenol oil base using the Cellon pressure method. The class number and height shall be according to the contract. The Contractor shall paint the holes bored in the pole with a pentachlorophenol solution. Poles shall have less than one hundred and eighty (180) degrees twist in grain over the full length. Sweep shall be less than four (4) inches. The Contractor shall bevel the tops of poles.

712.29 **Luminaires.** The type and style of luminaires and lamp equipment shall be according to the contract.

(A) **Luminaires for Roadway Lighting.** Luminaires for roadway lighting shall be the high-pressure sodium type according to the contract. They include a rear entry cast aluminum housing with a two (2) inch slipfitter for inner wiring, a polished aluminum reflector of snap-in design and a pressed glass refractor optical assembly.

The ballast shall start and operate the high pressure sodium lamp from the 240/480 volt 60HZ power source according to the contract and the lamp manufacturer. The ballast, including starting aid, shall protect itself against normal lamp failure modes. The ballast shall operate with the lamp in an open circuit or short circuit condition for six (6) months without significant loss of ballast life.

The fixture manufacturer shall submit a statement that the ballast furnished is in full compliance with the lamp-ballast specifications available to the fixture manufacturer from the lamp manufacturers at the time of bidding.

For nominal line voltage and nominal lamp voltage, the ballast design center will vary less than two (2) percent from rated lamp watts.

At any lamp voltage, from nominal through life, lamp wattage regulation spread at that lamp voltage shall not exceed two (2) percent for \pm ten (10) percent line voltage variation.

The luminaire manufacturer shall supply ballast electrical data and lamp operating volt-watt traces for nominal and \pm ten (10) percent rated line voltage to verify ballast performance and compliance with lamp specifications, for the rated life of the lamp.

The ballast shall reliably start and operate the lamp in ambient temperatures down to minus thirty (30) degrees Fahrenheit for the rated life of the lamp. Ballast primary current during starting may exceed normal operating current.

The lamp current crest factor shall not exceed 1.8 for \pm ten (10) percent line voltage variation at any lamp voltage, from nominal through life.

The ballast design shall be such that the normal manufacturing tolerance for capacitors of \pm six (6) percent will not cause more than a \pm two (2) percent variation in regulation throughout rated lamp life for nominal line voltage.

The luminaires shall provide the roadway a minimum average maintained illumination values according to the contract. The Contractor shall submit photometric data with certification of conformance. If increased luminaire spacing results with the proposed luminaire, the supplier shall so state at the time of bidding and submit a revised spacing plan.

The Contractor shall provide internal or external glare shield that eliminates stray light above the ninety (90) degrees nadir line for luminaries according to the contract. External shield shall be aluminum or zinc-coated steel.

(B) Luminaires for Pedestrian Stairways. Luminaires for pedestrian stairways include a cast aluminum recessed box with wire glass and cast aluminum louver cover, tamper proof screws and medium porcelain socket. The dimensions shall be according to the contract.

(C) Luminaires for Underpass Lighting. Luminaires for underpass lighting shall be die-cast housing that encloses ballast, lamp socket and specular aluminum reflector, and a refractor of molded, prismatic thermal, shock-resistant glass with polycarbonate vandal shield. The Contractor shall fasten the lens assembly by concealed hinges and a single point, positive acting latch. Fittings shall be non-ferrous. Unit shall be of the indicated size and the distribution of light output shall be according to the contract. The Contractor shall fuse each luminaire individually.

Luminaires shall be high-pressure sodium units and shall have integral regulator type ballasts, four hundred and eighty (480) volts, \pm ten (10) percent for multiple circuits.

(D) Luminaires for Sign Lighting. Luminaires shall be mercury vapor, cast aluminum, alzak reflector. The Contractor shall provide bracket raceway with the luminaire. The Contractor shall provide the unit with high-impact resistant glass covers with hinge and latch. Ballast shall be weatherproof, self-regulating at \pm thirteen (13) percent, and single-phase, sixty (60) cycle. The Contractor shall mount the ballast neatly in separate remote ballast raintight enclosures. Type of lamp shall be according to the contract. Voltage of the ballast shall be four hundred and eighty (480) volts.

712.30 Mast Arms. The mast arms for installation on wood poles shall be upswept zinc-coated steel pipe or seamless aluminum tube. The size shall be according to the contract. The Contractor shall end the mast arms in a two (2) inch slipfitter with inner wired type pole plates. The Contractor shall provide the length and rise of mast arm according to the contract. The mast

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arms may be steel or aluminum according to the contract. The Engineer will not allow a mixture of the type. *|
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Mast arms shorter than eight (8) feet shall be the tapered elliptical self-supporting type. Mast arms eight (8) feet and longer shall be of the truss type. The arms shall support the equipment shown in the plans and shall withstand one hundred (100) miles per hour winds. *|
*|

712.31 Expressway Sign Brackets. The Contractor shall make expressway sign luminaire brackets from structural steel beam of the sizes and types specified in the contract. After fabrication, the Contractor shall hot-dip zinc-coat the brackets according to ASTM A 123. On the work site, the Contractor shall paint the brackets with one (1) coat of accepted zinc-coated metal primer and three (3) coats of accepted, weatherproof dark green enamel according to Subsection 708.03 - Dark Green Enamel Paint. *|
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712.32 Light Sources.

(A) Light Source for Roadway Lighting Luminaires. Light sources for installation in roadway lighting luminaires shall be clear, mogul base, high-pressure sodium lamps. Voltage for one hundred fifty (150) watt high pressure sodium lamps shall be fifty-five (55) volts. |

(B) Light Source for Pedestrian Stairway Luminaires. The light sources for installation in pedestrian stairway luminaires shall be a medium base, inside frosted, one hundred twenty (120) volt, forty (40) watt incandescent lamp.

(C) Light Source for Underpass and Sign Luminaires. The light sources for underpass luminaires shall be high clear, mogul base, high-pressure sodium lamps.

-Light sources for sign luminaires shall be clear, mogul base, mercury lamps according to the contract. *|

712.33 Isolating Transformers. Isolating transformers for the series circuit roadway lighting luminaries shall be pole base or aerial according to the contract, with 6.6 ampere series primary. *|
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The isolating transformer for the series-multiple circuit shall be pole based type with 6.6 ampere series primary, six hundred (600) watt, with a secondary whose voltage is not higher than one hundred twenty-eight (128) volts at no load and not lower than one hundred fourteen (114) volts at full load.